

## Original Research Article

# EVALUATION OF BLOOD GLUCOSE-REGULATING POTENTIAL OF HONEY, COFFEE AND VITAMIN E IN NORMOGLYCAEMIC MALE WISTAR RATS

## ABSTRACT

This research studied the effect of honey, coffee and vitamin E on blood glucose level in non-diabetic experimental design. A total of 30 wistar rats weighing 200-220 grams were used. The experimental period lasted for 56 days. Blood glucose test was carried out on day 0, 18, 37 and 56. Data derived from the experiment was presented after mean comparisons and percentage change evaluation. The result showed that honey and honey co-administered coffee or vitamin E time-dependently reduced blood glucose level significantly. Vitamin E alone did not have any significant effect on blood glucose, but coffee alone time-dependently increased blood glucose level significantly. From this study, honey may be effective in regulating blood glucose level, vitamin E, except co-administered with honey, has no significant effect on blood glucose and coffee alone may cause a significant increase in blood glucose level, except co-administered with honey.

**Key words:** Blood glucose, Honey, Coffee, Vitamin E

## INTRODUCTION

Honey is consumed by many nationalities due to its pleasurable taste <sup>[1]</sup>. Some believe honey is a therapeutic agent in reducing stress <sup>[3][4]</sup>, others believe a spoon of honey may help relieve or prevent cardiac illnesses<sup>[1][4]</sup> and erectile dysfunction<sup>[7]</sup>. Despite all these, the sweetness of honey has made it somewhat controversial in relation to blood glucose regulation <sup>[5][10]</sup>. Not only honey, but also coffee, a common beverage <sup>[11][16]</sup> and vitamin E, an antioxidant <sup>[11]</sup>, are good candidates that possess controversial blood glucose regulating effect<sup>[11] [12]</sup>. Some reports have revealed the hyperglycemic potential of coffee <sup>[11]</sup> and no correlation effect to blood glucose after several doses of vitamin E <sup>[11]</sup>. other studies believe coffee may affect blood glucose either positively or negatively. More reports have reported non-significant change in relation to vitamin E administration <sup>[11] [23]</sup>. The aim of this study is to determine the effect of honey, coffee and vitamin E on fasting blood glucose in normal wistar rats.

## MATERIALS AND METHODS

### Purchase of treatment agents

Fresh honey was purchased from University of Port Harcourt food and drugs facility. The purity of the honey was authenticated in the laboratory for Microbiological sciences, Department of Microbiology, Faculty of Natural Sciences, University of Port Harcourt. Coffee was purchased from an online retail outlet. Vitamin E was purchased from Ebus Pharmacy in Port Harcourt.

### Experimental animals and protocols

Thirty (30) adult male wistar rats weighing 200 to 220 grams were obtained from the Experimental animal unit, Department of Human Physiology, University of Port Harcourt. Using the standard protocols<sup>[26]</sup>, all experimental animals were properly screened and confirmed by a Veterinarian in the institution to be physically healthy. With simple random technique of sampling, the animals were divided into four (6) groups containing six (5) rats per group. The animals were allowed to acclimatize for 2 weeks before the start of the experiment which lasted for 56 days. All animals had access to food and water *ad libitum*. The cages were properly cleaned twice daily to avoid coprophagy.

#### Study design

Groups	Treatments	Dose of treatment
1	feed and distilled water	<i>Ad libitum</i>
2	Vitamin E	0.15ml
3	Honey	2ml
4	Coffee	1.6ml
5	Honey + Coffee	2ml+1.6ml
6	Honey + Vitamin E	0.15ml+1.6ml

The normal rat feed from Anifeed® industries, containing carbohydrate, proteins and fat, in a balanced ratio, was used as feed throughout this research.

#### Treatment method

All treatment agents were administered via orogstric route following standard laboratory procedures<sup>[10]</sup>.

#### Collection of blood samples

Blood was collected four (4) times in four (4) different days of equal interval. The collection of blood samples include;

Days	Experimental periods
0	before onset of administration of treatment agents
18 <sup>th</sup>	18 <sup>th</sup> day after onset of administration of treatment agents
37	37 <sup>th</sup> day after onset of administration of treatment agents
56	56 <sup>th</sup> day after onset of administration of treatment agents

#### Blood Glucose Test

Blood glucose test was carried out using a Finetest® glucometer purchased from Technomed® Plaza in Borokiri, Port Harcourt. The corresponding test strips were used. The method was based on the biochemical principle of enzyme catalysis<sup>[27]</sup>. Whereby, glucose oxidase enzyme catalyzes the oxidation of glucose to gluconic acid and hydrogen peroxide which can be detected by a change in absorbance of the test sample. The animals were subjected to fast for about 12 hours before collection of blood samples.

#### Statistical Analysis

Experimental data are presented in Mean  $\pm$  Standard error of mean (SEM). Percentage (%) change was also calculated to make the data well translated. SPSS 20.0 was used for all

calculations and statistical analysis such as One-way analysis of variance (ANOVA). Values are significant at  $p \leq 0.05$  or at confidence interval of 95%.

## RESULTS

**TABLE 1; Effect of honey, coffee and vitamin E on blood glucose**

Treatments	BLOOD GLUCOSE						
	(mmol/L) Day 0	% 0-18	(mmol/L) Day 18	% 18-37	(mmol/L) Day 37	% 37-56	(mmol/L) Day 56
Control	4.42±0.095	1.80	4.50±0.095	-1.7	4.42±0.095	0.45	4.44±0.095
Vit E	4.30±0.095	0.93	4.34±0.095	-0.4	4.32±0.095	1.38	4.38±0.095
Honey	4.52±0.095	-7.1	4.20±0.095	-11.4	3.72±0.095 <sup>a0</sup>	-17	3.08±0.095 <sup>a0</sup>
Coffee	4.28±0.095	8.8	4.66±0.095	2.1	4.76±0.095 <sup>0</sup>	17.2	5.58±0.095 <sup>a0</sup>
Honey+Coff	4.38±0.095	5.9	4.64±0.095	-12.0	4.14±0.095	-15.4	3.50±0.105 <sup>a0</sup>
Honey+Vit E	4.54±0.095	-4.1	4.36±0.095	-16	3.66±0.095 <sup>a0</sup>	-15.3	3.10±0.095 <sup>a0</sup>

N=5

<sup>a</sup>  $p < 0.05$  was considered significant compared with control on same day

<sup>0</sup>  $p < 0.05$  was considered significant compared with day 0 of same treatment

**TABLE 2; Percentage relative effect of honey, coffee and vitamin E on blood glucose**

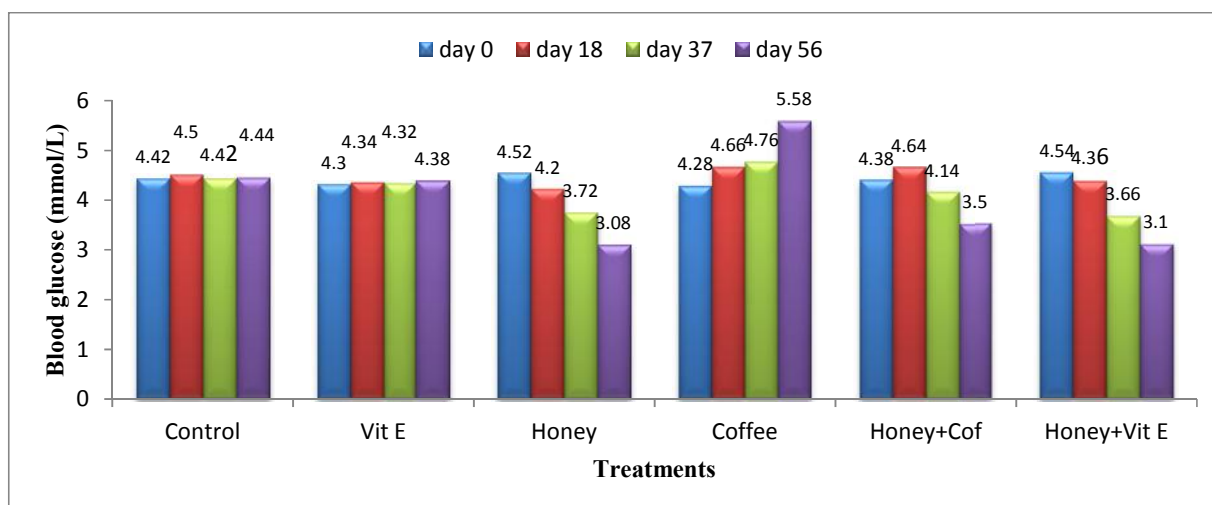
Treatments	0→18 (%)	0→37 (%)	0→56 (%)
Control	1.8	0	0.5
Vit E	0.9	0.5	1.9
Honey	-7.1	-17.6	-32
Coffee	8.8	11.2	30.4
Honey+Cof	5.9	-5.5	-20.1
Honey+Vit E	-4.1	-19.4	-32

Negative sign indicates a percentage (%) decrease.

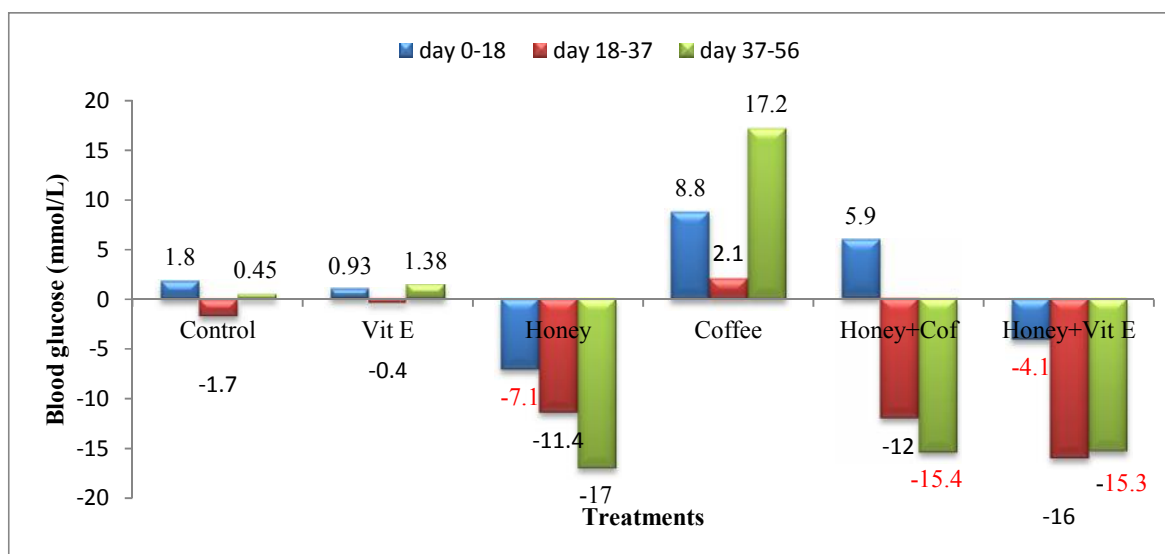
All values are relative to day 0.

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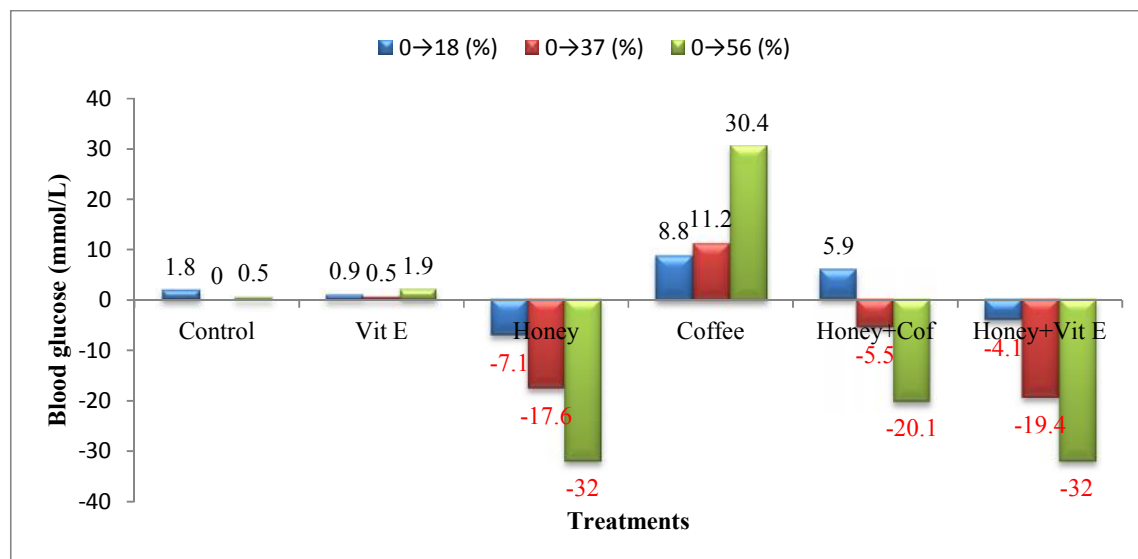
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**FIGURE 1;** Effect of honey, coffee and vitamin E on blood glucose.



**FIGURE 2;** Effect of honey, coffee and vitamin E on blood glucose using % change.



**FIGURE 3;** Effect of honey, coffee and vitamin E on blood glucose using % change in relation to day 0.

**From table 1;**

Vitamin E treated groups had a non-significant change in blood glucose from day 0 at  $4.30 \pm 0.095$  to day 18 ( $4.34 \pm 0.095$ ), day 37 ( $4.32 \pm 0.095$ ) to day 56 ( $4.38 \pm 0.095$ ). The percentage change was 0.93, -0.4 and 1.38 for day 0 to 18, 18-37 and 37 to 56 respectively. Honey treated group had a significant decrease in blood glucose from day 0 at  $4.52 \pm 0.095$  to day 37 ( $3.72 \pm 0.095^{a0}$ ) with a percentage change of -7.1 to day 56 ( $3.08 \pm 0.095^{a0}$ ) with a percentage change of -17 from day 37. Coffee treated group had a significant increase in blood glucose from day 0 at  $4.28 \pm 0.095$  to 37 ( $4.76 \pm 0.095^0$ ) also further increased to  $5.58 \pm 0.095^{a0}$  on day 56. The percentage change from day 0 to day 37 was 2.1; from day 37 to day 56 was 17.2. Coffee group had the highest percentage positive change in blood glucose compared to other treatment groups. The group co-administered honey and coffee had a time-dependent change in blood glucose. The change in blood glucose was not significant from day 0 ( $4.38 \pm 0.095$ ) to day 18 ( $4.64 \pm 0.095$ ) percentage change of 5.9 and day 37 ( $4.14 \pm 0.095$ ) percentage change of -12.0 from day 18. The blood glucose decreased significantly on day 56 ( $3.50 \pm 0.105^{a0}$ ) with a percentage change of -15.4 from day 37. The group co-administered honey and vitamin E had a time-dependent change in blood glucose. The change in blood glucose was not significant from day 0 ( $4.54 \pm 0.095$ ) to day 18 ( $4.36 \pm 0.095$ ) percentage change of -4.1 but blood glucose significantly decreased from day 37 ( $3.66 \pm 0.095^{a0}$ ) percentage change of -16 from day 18. The blood glucose further decreased significantly on day 56 ( $3.10 \pm 0.095^{a0}$ ) with a percentage change of -15.3 from day 37.

**From table 2;**

The percentage change relating each blood glucose test day to day 0 was presented. The highest percentage decrease was in honey-treated groups, from day 0 to day 56 at -32%. The group co-administered honey and coffee had its highest percentage decrease in blood glucose from day 0 to day 56 at -20.1. The group co-administered honey and vitamin E had the highest percentage decrease in blood glucose from day 0 to day 56 at -32. In all 3 of the aforementioned groups, it was well translated that the decrease in blood glucose was time-

dependent. Coffee treated groups presented the highest time-dependent increase in blood glucose compared to all treatments. This increase in blood glucose was highest from day 0 to day 36 at 30.4.

## DISCUSSION

The active biochemical components of honey may probably be responsible for its blood glucose lowering effect<sup>[7] [14]</sup>. Honey has an abundance of micro-minerals<sup>[1]</sup> most of which serve as important components in insulin signalling<sup>[5]</sup> and sensitivity<sup>[2]</sup>. Some constituents like fructose and palatinose enhance or activate insulin response system<sup>[9]</sup>, captivation of cellular glucose<sup>[3]</sup> and delay of digestion and absorption of starch<sup>[4]</sup>. One major cause of glucose intolerance is pro-oxidative changes<sup>[10]</sup>. Pro-oxidation may be induced by physiologic changes like post-prandial hyperglycemia<sup>[11] [16] [18]</sup>. Honey, in this study, may have the potency of regulating post-prandial blood glucose surge. At the studied dose, honey can thus be said to be effective in regulating blood glucose level under normal conditions; this is in agreement with earlier reports<sup>[15]</sup>. Coffee due to its caffeine content<sup>[11] [17]</sup> may probably have altered the plasma level of catecholamines<sup>[11]</sup>, cortisol<sup>[11] [19]</sup> and growth hormones<sup>[11]</sup>. These diabetogenic factors may be the stimuli behind the glucose increase in coffee treated groups. This is in correspondence with earlier reports<sup>[11]</sup>. Caffeine in coffee increases the synthesis of energy currencies like adenosine triphosphate (ATP)<sup>[14]</sup> through oxidative phosphorylation. Adenosine triphosphate (ATP) is an allosteric inhibitor of glycolysis at the level of phosphofructokinase<sup>[30]</sup>. This allosteric inhibition causes glycolysis to be 'tuned-OFF', followed by a prolonged increase in blood glucose. Vitamin E effect on blood glucose has caused much controversy<sup>[21] [23]</sup>. The majority of studies have pointed at either an indirect effect as a result of its antioxidant function<sup>[11] [26] [27]</sup>. If this is the case, then oxidative stress may be the reason behind the increase in blood glucose<sup>[24]</sup> of coffee treated groups in this study and vitamin E treatment maintained blood glucose level within a given range due to its antioxidant function. The direct effect of vitamin E in this study may be its role as a coenzyme or protector of enzyme systems during glucose homeostasis. This is in agreement with earlier reports<sup>[11] [24]</sup>. The group co-administered honey and coffee had a time-dependent decrease in blood glucose compared to the effect of coffee alone which may be due to the synergy between the glucose-regulating components in honey like phenolic acids, kaempferol, fibers, chromium and magnesium, and the bioactive glucose-lowering agent in coffee called Chlorogenic acids<sup>[11] [16]</sup>. Co-administration of honey and vitamin E in this study revealed a time-dependent increase in blood glucose. This is a good example of blood glucose regulation caused by organic biomolecules, inorganic biomolecules and antioxidant systems, all acting in synergy.

## CONCLUSION

From the outcome of this study, honey may be consumed for a prolonged period if a desire to reduce blood glucose is to be achieved. Effect of Vitamin E on blood glucose for the particular treatment dose and for the time frame of this study was not significant. Coffee, should not be advised as a beverage of choice for prediabetics or diabetics. Co-administration of coffee and honey as well as honey and vitamin E may be of benefit in blood glucose regulation.

## RECOMMENDATION

Further research on diabetes-induced experimental model is recommended.

## 181 CONSENT

182 It is not applicable in this study

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